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Election forecasting

Development of the Constant Sum Scale to be used in telephone surveys

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The Constant Sum Scale has been successfully tested to forecast election results in face-to-face surveys. As political polls are carried out using telephone surveys, there was a need to test the scale for use in telephone surveys. In this study the Constant Sum Scale was tested for implementation in a telephone survey. The study was carried out during an election that used the single transferable voting system, and the Constant Sum Scale was utilised to forecast the election outcome. The validation against the election results showed that the Constant Sum Scale was successful in ranking the candidates in the order they prevailed in the final electoral result. Respondents' understanding, based on the judgements given by interviewers, was at a satisfactory level. The overall results suggest that the Constant Sum Scale can be implemented effectively in telephone surveys and is recommended for telephone polling of voters.

Introduction

Probability-based scales have been used successfully to estimate future behaviour in marketing. The probabilistic nature of these scales allows the means produced to be interpreted in proportionate terms. At least three forms of probability scale – Juster Scale, Verbal Probability Scale and Constant Sum Scale – are used in the marketing literature. The Juster Scale, originally implemented in face-to-face surveys, was developed to estimate the adoption rate of durables (Juster 1966). Researchers subsequently developed this scale for implementation in self-completion questionnaires applied via mail (Gendall *et al.* 1991) and internet-based surveys (Parackal & Brennan 1999). The Verbal Probability Scale is an adaptation of the Juster Scale for

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implementation in telephone surveys (Brennan *et al.* 1995a). This scale was tested successfully for estimating adoption rates, purchase frequencies and voting behaviour. In recent years, the Verbal Probability Scale has been tested to benchmark public issues in a social marketing context (Sharp & Riebe 2000; Parackal *et al.* 2007). The Constant Sum Scale was specifically developed for collecting data for mutually exclusive behaviours (Metefessel 1947). This scale is recommended to estimate switching behaviour, market shares and customer preferences (Metefessel 1947; Reibstein 1978; Hoek & Gendall 1997). It uses an approach that requests respondents to distribute a set number of tokens (usually ten) across mutually exclusive options. The scale produces data that logically represent the adoption or preferences of the mutually exclusive options. The summation of the means across the options always adds up to 10 or 1. Consequently, the means can be interpreted in terms of proportions of the sample that favour the respective options. This latter feature of the Constant Sum Scale is something that the other probability scales have failed to achieve when used on mutually exclusive options (Hoek & Gendall 1993, 1997; Parackal & Brennan 1999; Flannelly *et al.* 2000a, 2000b).

The focus of the current paper is on the use of the Constant Sum Scale to collect share of votes in order to forecast a political election outcome. The scale has been tested and observed to produce valid election forecasts (Hoek & Gendall 1997) in a face-to-face survey. For the scale to be useful to pollsters it needs to be implemented in telephone surveys, as it is the primary method used to poll voters. This paper reports a study that tested the Constant Sum Scale to be used in telephone surveys for forecasting election results. In the following sections a background history of the Constant Sum Scale is first provided, followed by the results of a study that tested the scale for implementation in a telephone survey.

Constant Sum Scale

In the academic literature, the Constant Sum Scale (CSS) appeared for the first time in 1947, when it was suggested by Metefessel (1947) as a method for collecting comparative judgements for two or more items. Metefessel's scale required respondents to assign 100 units – 'pennies, chips, points, marks, or material that can be counted' (Metefessel 1947, p. 230) – to the items, in order to convey judgements. The total number of units assigned to the items was interpreted as a percentage and was suggested as a way of using the CSS to collect rankings and ratings of mutually exclusive alternatives. By using 100 units to convey rankings or

ratings, the distances or differences between the options were established. The data thus can be analysed using parametric tests such as the Analysis of Variance (ANOVA) technique. Metefessel (1947) suggested the scale be used to forecast election results but never tested it for this purpose.

The scale was included in a study that tested 16 methods used to forecast repeat purchases (Alexrod 1964). The version of the CSS used in this study asked respondents to distribute 11 cards across the options instead of the 100 points used by Metefessel (1947). The following instructions were used to implement the scale:

Here's a sheet on which I have listed several brands of [product class]. Next to each brand is a pocket. Here are 11 cards. I would like you to put these cards in the pockets next to the brands to indicate how likely it is that you would buy each brand. You can put as many cards as you want in front of any brand or you can put no cards in front of a brand.

(Alexrod 1964, p. 4)

The CSS was observed to produce the most accurate forecast for repeat purchases of all the 16 methods. In contrast with alternative scales, the CSS provided a greater discrimination between respondents who intended to re-purchase and those who did not.

Reibstein (1978) compared the CSS with two other methods, one measuring preference (Dollar Metric Model) and the other attitude (Multi-attribute Attitude Model). The comparison was intended to identify the method that produces the best forecast for brand choices. The CSS collected the probabilities of purchasing the brands by asking respondents to distribute 100 points across the alternatives. The total points assigned to each brand conveyed its choice in probability terms. The Dollar Metric Model and Multi-attribute Attitude Model collected preference and attitude data that were converted to probabilities of choice using Luce's Choice Axiom (Luce 1959) for comparison with the CSS. The result once again showed that the CSS produced significantly more accurate estimates for brand choice than the two alternative methods. The CSS in Reibstein's study estimated the most frequently purchased brands correctly for 65% of the respondents, followed by the Dollar Metric Model (52%) and the Multi-attribute Attitude Model (22%).

The application of the CSS was extended to estimating purchase levels of fast-moving products by Hamilton-Gibbs *et al.* (1992). In the case of fast-moving products, a household purchases several units over a period of time; finding out whether households would purchase or not (purchase rate) therefore has very little value. A useful estimation would be the

Election forecasting

number of units that would be purchased over a period (purchase level). For this application, Hamilton-Gibbs *et al.* (1992) modified the scale to be made up of a grid printed on a flash card and ten tokens (see Figure 1). The columns on the grid represent the number of units, ranging from zero to 12, and the tokens represent probabilities, chances or odds. Respondents conveyed their probability of purchasing different units of the product for the period in question by placing the corresponding number of tokens in the respective columns. For example, if a respondent thought there were five, three and two chances out of ten to purchase one, two and three units, they conveyed this by placing five, three and two tokens in the columns corresponding to the respective units.

The following example was included to convey the task required of respondents:

... if respondents felt there was a 50-50 chance the household would purchase either two or three tubes of toothpaste over the four week period, they would assign five tokens to each of the squares representing two and three tubes of toothpaste. All 10 counters, and only 10, had to be used.

(Hamilton-Gibbs *et al.* 1992, p. 19)

Hamilton-Gibbs *et al.* (1992) tested the above version of the CSS against a multiple question approach. This latter method asked respondents to state probabilities progressively for each number of units until they gave a zero probability. For all the test products (toothpaste, margarine, butter, eggs, spaghetti, ice cream and cheese), the CSS surpassed the multiple question approach in accuracy. Studies that replicated Hamilton-Gibbs *et al.*'s (1992) version of the CSS on branded product (e.g. Coca-Cola, Campbell's canned soup) reproduced completely their original result (Seymour *et al.* 1994; Brennan *et al.* 1995b).

Predicted purchases for the next four weeks													
	0	1	2	3	4	5	6	7	8	9	10	11	12
Toothpaste	<input type="checkbox"/>												
Margarine	<input type="checkbox"/>												
Butter	<input type="checkbox"/>												
Eggs	<input type="checkbox"/>												
Spaghetti	<input type="checkbox"/>												
Ice cream	<input type="checkbox"/>												
Cheese	<input type="checkbox"/>												

Figure 1 Hamilton-Gibbs *et al.*'s (1992) Constant Sum Scale

Hoek and Gendall (1997) applied the CSS to forecast election results in an MMP electoral system. Under this system voters have two votes: one for a candidate and one for a party. The scale listed the names of parties and candidates. Alongside each party, ten cells that numbered from 1 to 10 were aligned. Interviewers gave respondents ten stickers, with instructions to distribute them across the list of parties to indicate their chances. The following instructions were included to convey the task required:

If you are certain, or practically certain to vote for a party you would put all 10 stickers beside it. If you thought there was no chance, or almost no chance of you voting for that party, you would not put any stickers next to it. If you were uncertain about voting for that party you would place as many stickers next to it as you think there should be. Could you please use these stickers to indicate the chances that you will vote for each of the parties listed in this grid.

(Hoek & Gendall 1997, p. 20)

The CSS was compared with a conventional method that required respondents to indicate their absolute choice of candidate or party: 'Which of these [candidates/parties] do you plan to vote for in this year's General Election?' (Hoek & Gendall 1997, p. 8). The mean absolute error of the forecast produced for the candidate vote on the CSS was only slightly better than that produced using the conventional method (3.1% versus 3.8%). For the party vote, however, the CSS clearly produced the better forecast. The mean absolute error obtained on the scale was 1.8%, compared to 3.0% using the conventional method.

In all the comparisons discussed so far the CSS was seen to produce more accurate estimates. All the same, the usage of the scale to forecast election outcomes will be practical only if it can be implemented in telephone surveys. The remainder of this paper is devoted to a study that tested the CSS for forecasting election results by implementing it in a telephone survey. The following sections provide the objective of the study, methodology employed and the results obtained.

Research objective

The objective of the study was to test the CSS for implementation in telephone surveys. The test comprised the following:

- Validation of the estimates produced on the CSS when implemented in a telephone survey.

- Assessment of how well respondents understood the CSS and the task required of them when implemented in a telephone survey.

Research hypotheses

To achieve the above objectives, the CSS was implemented in a telephone survey carried out during the 2004 Dunedin Mayoral Election in New Zealand. This election followed the single transfer vote (STV) method that requires voters to rank the candidates by their preference. STV election was appropriate for validating the CSS for implementation in a telephone survey as rank ordering was one original purpose for developing the scale (Metefessel 1947). In the present study, the investigation was carried out to determine the extent to which the CSS reproduced the final rank order of candidates in the 2004 Dunedin Mayoral Election in New Zealand, when implemented through a telephone survey. Based on the previous performance of the CSS reviewed earlier, the following hypothesis was put forward for testing:

H1: The rank ordering of candidates produced with the CSS would be consistent with the final rank ordering of candidates in an STV election.

The winner (or winners, depending on the number of vacancies) in an STV election is (are) decided based on the candidates reaching a quota set. The quota is derived with an equation consisting of the total number of valid votes and the number of seats to be filled ((total number of valid votes) \div (number of seats to be filled+1)) + 1) (Gilmour 2007). Candidates that reach the quota based on the voters' first preference are declared winners. If no candidates reach the quota then a process of vote transferring is initiated. In this process the candidate at the bottom of the order is eliminated and the second preference of the voters who supported that candidate is brought into consideration to produce a new distribution of the share of votes for the remaining candidates. Candidates who reach the quota based on the new distribution of votes are declared winners. If no winners are found, the process is repeated by eliminating the next candidate at the bottom of the order. The process of elimination and redistribution of voters' second preference is repeated until the required numbers of winners are found (see Gilmour 2007 for more details of calculating STV votes). The proportions of the share of the total votes after the vote-transferring process provide a clear picture of the relative position

of candidates in the elections. With this method every voters' preference is taken into consideration to produce the final rank order.

In theory, the CSS requires respondents to make judgements by taking into consideration their relative preferences or support. Respondents conveyed their relative preference or support by distributing the tokens across the options. Therefore the means produced on the CSS should produce satisfactory forecasts of the election results. The hypothesis put forward for testing was as follows:

H2: Mean estimates produced on the CSS will provide a satisfactory forecast of the share of votes received by the candidates in an STV election.

Studies that tested the CSS observed that respondents, in general, did not experience difficulty understanding how the scale operated and the task required of them. To assist those who may experience difficulty, the literature suggests explaining the scale using a practise question before asking the actual question (Hoek & Gendall 1997). The present study used a practise question to explain the CSS over the telephone. Before moving on to the actual question, interviewers asked respondents whether they wanted the explanation to be repeated. They proceeded to ask the actual question only if respondents answered 'no' to this question. Based on the previous literature, the following hypothesis was proposed for testing:

H3: Use of a practise question before the actual question will assist respondents to understand the working of the CSS in a telephone survey better.

Research approach

To generate data to test the above hypotheses, the CSS was implemented using a web-assisted telephone interviewing system (WATI). The system was developed to draw stratified random samples of household telephone numbers in the city of Dunedin in New Zealand. Stratification employed was based on the suburbs of Dunedin. The number of participants to be interviewed for each suburb was determined using population figures from the 2001 Census. For each suburb, the telephone prefixes (the first three numbers relating to the exchange) were identified. Suburbs with one exchange box had the entire quantity of telephone numbers assigned to that one prefix. For suburbs with more than one exchange, the quantity of

telephone numbers was divided equally to the corresponding prefixes. The remaining four digits of the telephone number were randomly generated from a pool of all possible numbers ranging from 0 to 9999.

The number of telephone numbers needed to produce one interview was determined by a pilot study on 100 participants. This study produced a hit rate of 22 call-outs to secure one successful interview. The number of telephone numbers generated for the suburbs were weighted by the hit rate. A computer auto-dialling system was used to test the numbers for active line connection before entering them in to WATI to be supplied to interviewers. Within a household, interviewers identified the adult respondent over the age of 18 to interview using the next-birthday rule. Recalls were attempted until a response was obtained. Refusals were replaced by another number randomly selected from the same suburb. A total of 2674 numbers were dialled to produce 485 interviews. The response rate calculated after removing the ineligible numbers and refusals was 45%. The interviews were carried out from 23–28 September 2004. Ballot papers for the election were delivered to voters by post on 17 September, to be returned by 9 October 2004, and the results were published on 17 October 2004.

Constant Sum Scale

The electronic version of the CSS used in this study followed Hoek and Gendall's (1997) format of a grid and ten tokens (see Figure 2). The grid listed the candidates and the adjoining ten boxes provided room for the tokens assigned. The buttons (with plus and minus signs) were provided for the assigning and re-assigning of tokens to the candidates. The instrument was handled by the interviewers in accordance with the responses given by respondents. Figure 2 is a screen shot of the CSS and the rating question on how well respondents understood the CSS, as viewed by the interviewers.

To minimise respondents' difficulty in understanding the CSS and the task required, an explanation with a practice question was used. The practice question used in the present study was on nominations for the 'Personality of the Century' award. Seven individuals, well known to the New Zealand public (Sir Edmund Hillary, Sir Peter Blake, Jonah Lomu, Dame Kiri Te Kanawa, Janet Frame, David Lange and Sir Robert Muldoon), were used in the practice question. The wording of the practice question was as follows:

Please indicate your preferred choices to nominate the following individuals for the New Zealand Personality of the Century award.

Voting Probability Actual Question - Mozilla Firefox

File Edit View Bookmarks Tools Help

Now for the actual question,

Please tell me how you intent to vote in coming mayoral election. As with the sample question, you have ten token to convey your choices:

If you were certain or practically certain that you would vote for a candidate, you would assign all ten tokens to that candidate. If you thought there was no chance, or almost no chance of voting for that candidate, you would not assign any token to that option. If you were uncertain of voting for that candidate, you would place as many tokens to that candidate as you think there should be.

Please tell me your chances to vote for each candidate as I read out their names. The names are not in any particular order

(Interviewers please Use the "+" button to assign the coins to the options. Use the "-" button to remove some or all coins assigned.)

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Election forecasting

Respondents were provided with the following explanation as to how the tokens were to be distributed:

To answer this question, I would like you to think of your nomination in terms of choices/chances/odds/probabilities out of 10. If your choices for nominating each individual were in the following order:

- 5 choices out of 10 to nominate ‘Sir Edmund Hillary’ then you would give ‘5 tokens’ for Sir Edmund Hillary. You are now left with 5 tokens.
- 1 choice out of 10 to nominate ‘Sir Peter Blake’ then you would give ‘1 token’ for Sir Peter Blake. You are now left with 4 tokens.
- 3 choices out of 10 to nominate ‘Jonah Lomu’ then you would give ‘3 tokens’ for Jonah Lomu. You are now left with 1 token.
- 1 choice out of 10 to nominate ‘Dame Kiri Te Kanawa’ then you would give ‘1 token’ for Dame Kiri Te Kanawa.
- You now have no tokens left, hence, the chance of you nominating ‘Janet Frame, David Lange and Sir Robert Muldoon’ is ‘0’. In other words, there is no chance of you nominating Janet Frame, David Lange or Sir Robert Muldoon for the award.

After taking the respondents through the practice question once, interviewers enquired whether they wanted it to be repeated. The practice question and explanation were repeated until the respondents expressed the confidence to progress to the actual question. Interviewers recorded the number of times they repeated the practice question. When respondents were ready to answer the actual question, the interviewers immediately indicated their judgement on how well the respondents understood the practice question. Judgements were collected on a seven-point scale where 1 represented ‘excellent understanding’ and 7 represented ‘poor understanding’.

The actual question followed the same format as the practice question, only the names were replaced with the candidates in the 2004 Dunedin Mayoral Election in New Zealand. In the actual question, the respondents indicated their responses in token terms for each candidate. After collecting the responses, as with the practice question, interviewers indicated their judgements on how well respondents understood the actual question. The

CSS was validated by comparing the estimates produced for the candidates in the election against the election results.

For the sake of obtaining a comparison for the CSS, respondents were asked to rank-order the candidates according to preference, similar to what voters had to do in an STV election. The STV system was implemented in the study by interviewers reading out the names of candidates in alphabetical order of their surnames, as in the election ballot paper that respondents had received from the election officials at the time of the interview. Respondents responded by indicating 'first', 'second', 'third', 'fourth', 'fifth' or 'sixth', to reflect the order of candidate preference. This item was positioned after the CSS in the questionnaire and will be referred to as the 'STV scale' in this paper from here on. The STV scale was included as an equivalent to the absolute choice method used in the first-past-the-post election system. Consequent to the non-experimental nature of the comparison between the two scales, no hypothesis was created for testing. The results, however, are reported and discussed in this paper for the sake of future research direction.

Results

Rank order

The CSS was reasonably satisfactory to forecast the proportion and rank order, after the transfer of votes (Gilmour 2007). The mean absolute error observed was 2.7, with the absolute error ranging from 1% (Knowles) to 7.1% (Farry).

Preference of candidates based on the STV scale was calculated in a similar way to that used in STV elections (Gilmour 2007). The mean absolute error was 3.7 and the absolute error ranged from 0% (Knowles) to 10.6% (Farry). The rank order for this method was not consistent with the election results. The proportions of votes for candidates and the rank order produced on the two scales are shown in Table 1. The error columns in the table show the difference between the estimates and the election results for the two scales.

Assessment of respondents' understanding of the CSS

Respondents' understanding of the CSS was assessed by the number of times the interviewers had to take respondents through the practice question. For a large majority of the sample (98%), the practice question

Election forecasting

Table 1 Estimates of election results produced by the CSS and STV scale

	CSS			STV scale			Election results	
	%	Rank order	Error	%	Rank order	Error	%	Rank order
Chin	41.1	1	-2.6	54.0	1	10.3	43.7	1
Farry	31.5	2	-7.1	28.0	2	10.6	38.6	2
McBey	11.0	3	2.9	6.0	4	-2.1	8.1	3
Stevenson	10.7	4	4.4	9.0	3	2.7	6.3	4
Vandervis	4.2	5	1.1	2.6	5	-0.5	3.1	5
Knowles	1.4	6	1.0	0.4	6	0	0.4	6
Mean absolute error				2.7			3.7	

was applied only once. Of the small proportion of respondents who wanted the practise question repeated, ten wanted it twice and two wanted it three times. Most of the 12 respondents belonged to the older age group ('over 40') with just two belonging to the '25–35' group. All the same, even for these respondents the understanding of the CSS increased after the practice question.

Mean judgement of respondents' understanding of the CSS given by interviewers moved from 2.9 for the practice question to 1.9 for the actual question (the lower mean implying excellent understanding).

The mean judgements produced for the practice and actual question are shown in Table 2.

The above means suggest that the sample exhibited reasonable understanding of the CSS. The understanding significantly increased for the actual question (t value = -2.69 , df 499 with an associated p value of 0.007). Mean ratings for both questions were comparable across age categories, gender or education levels ($p > 0.05$).

Table 2 Mean ratings of understanding of the practice and actual question

	Mean	95% CI
Practice question	2.04	1.86–2.21
Actual question	1.81	1.74–2.10

Research reflections

The present study tested the CSS for implementation in a telephone survey. The approach consisted of asking respondents to imagine being given ten tokens. The interviewers read out the options, and asked respondents to assign the tokens to convey the chances or probability of performing the behaviour under investigation. The approach used a practice question to explain the CSS to the respondents before asking the actual question, which was asked only after respondents confirmed they were comfortable

using the CSS. The study was carried out on the 2004 Dunedin Mayoral Election, which used the STV method to decide the winner. Validation of the CSS implemented over the telephone was carried out against the election results and the assessment of respondents' understanding was based on the data collected from interviewers.

The CSS was successful in reproducing the rank order of candidates in the final results. The estimations of two candidates (McBey and Stevenson) were very close to each other, yet the ordinal nature – that is, the lack of distance between positions – meant that the two could be assigned to third and fourth positions in the order, thus being consistent with the election results. Even if these two candidates were treated as ties in the rank order, it would still be a safer estimation of the final results.

In an STV election, establishing the rank order is more important than the share of votes. The CSS, in this study, was able to produce a rank order consistent with the election results. The CSS also estimated the share of vote with reasonable accuracy (absolute mean error of 2.7%). Thus, based on this study, CSS could be implemented via telephone surveys for the purpose of polling.

Respondents' understanding of the CSS based on the interviewers' judgement was at a satisfactory level. The use of the practice question enhanced their understanding of the CSS. It is suggested that a practice question be used to assist anyone who might have difficulty understanding the task required, as noted in the literature (Hoek & Gendall 1997). The inclusion of a practice question has ramifications for the length and cost of the survey. All the same, the need for a reliable instrument for pollsters justifies the cost, particularly because political elections are won by very narrow margins (e.g. 2005 New Zealand General Election – Labour Party 41.1% and National Party 39.1%; 2005 German Federal Election – Angela Merkel 35.2% and Gerhard Schröder 34.2%; 2004 US Presidential Election – 47.9% to George W. Bush and 48.4% to Al Gore).

While the study was not designed to compare the CSS with the STV scale, nevertheless a discussion on the pattern of error produced was appropriate, particularly to suggest future research directions. The absolute mean error was less for the CSS in comparison with the STV scale. This was because of the more accurate estimate produced for the lead candidate (Chin). In this particular election there was only one vacancy to be filled, hence it was important to get the lead candidate correct. It is worth noting that the CSS was able to establish the lead candidate with reasonable accuracy (-2.6% error vs 10.3% error). The

error pattern across candidates showed that the CSS produced less error for the two strong candidates (Chin and Farry) in this election, whereas the STV scale produced less error for the trailing candidates. The CSS underestimated the election results of the two strong candidates, whereas the STV scale overestimated the results for these candidates. As the comparisons between the two scales were not strictly experimental, a conclusive claim regarding their relative performance cannot be made. All the same, the error pattern observed suggests the existence of differences. It is suggested that a future study be carried out to establish the relative performance of the two scales.

Conclusion

This study tested the CSS for implementation in a telephone survey. The approach suggested comprises asking respondents to imagine receiving ten tokens from the interviewers, and then of asking them to assign the tokens to options to convey their chances or the probability of performing the behaviour in question. The approach includes the use of a practise question to enhance respondents' understanding of the CSS. The measurements of respondents' understanding of the CSS suggest that they had a good understanding of the scale. The validation of the CSS against the 2004 Dunedin Mayoral election results showed that this approach of employing the CSS in telephone surveys was appropriate to collect the share of votes and ranking of candidates in election polls.

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